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ABSTRACT

This paper considers ways in which the organization of text can be made explicit through verbal cuing and the ways in which this organization can be related to the cognitive processes of the reader. It is noted that the textual factors supplementary to the main content play an important part in the comprehension of text and are, thus, important elements in the design of text; and that the mathemagenic approach--which refers to a group of devices known as adjuncts to text and which seeks to orient learners to the text and show them what is relevant and important--is essentially text control of the learning process. A comparison is then made between the mathemagenic approach and the generative approach, which emphasizes both learner involvement and learner control of the processes that produce comprehension. Adjunct aids and their role in the context of text-induced cognitive processing are then considered, including advance organizers ("if it works, it is an advance organizer"); graphic organizers; adjunct questions; and learning objectives. It is concluded that, for the instructional designer, the reconsideration of adjunct aids as verbal cuing devices within a cognitive perspective of the reading process provides a defensible framework and challenges the designer to implement on a basis of principle rather than practice. (27 references) (CGD)

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Introduction

It has been argued that the content and structure of passages of text are inextricably linked and that students will learn from text better if they can follow the organisation of the material and later use that organisation (Brandt, 1978). It has also been argued that, since comprehension of text can be a cognitively demanding task, authors can help readers to comprehend and recall text information by making sure that the design of their text supports each of the component comprehension processes that the readers must perform, including, *inter alia*, identifying the important ideas in text, organising those ideas, and integrating them with prior knowledge (Glynn & Britton, 1984). The organisation of text can be made explicit through both verbal and typographical cueing systems (Glynn, Britton & Tillman, 1985) but many of the techniques for instructional text design have been developed in either an a-theoretical framework, or a framework which is not very defensible in the light of recent cognitive research.

The purpose of this paper is to consider ways in which the organisation of text can be made explicit through verbal cueing and the ways in which this organisation can be related to the cognitive processes of the reader. In doing so, the paper re-interprets current practice within a cognitive framework.

Highlighting structure and organisation through verbal cues

It has been argued that verbal cueing can be of either a linguistic nature, ie concerned with the semantic and syntactic structure of the text, or of an instructional design nature, ie concerned with verbal support such as advance organizers and adjunct questions which, although an integral part of the text, are not really part of the content (Stewart, 1986).

The concern of this paper is not with the linguistic aspects of text such as structure, coherence, and content, but with those textual factors supplementary to the main content which play an important part in the comprehension of text and are, thus, important elements in the design of text.

In a review of instructional psychology Resnick (1985) acknowledged that the current view of reading comprehension was too recent to have yet generated many instructional applications, but that, *inter alia*, older lines of work on advance organizers, questions, and other adjuncts to text might eventually be reinterpreted in light of the constructivist view of the reading process. For the purpose of this paper, the term 'adjuncts to text' will be taken to include such devices as the statement of behavioural objectives, the provision of advance organizers, the inserting of questions, and the activation of prior knowledge.

Jonassen (1985) has used Rothkopf's (1980) 'mathemagenic' process to refer to this group of devices, contrasting them with 'generative' processes which he considers to be more in line with a cognitive approach to learning. According to Jonassen, the mathemagenic approach seeks to orient learners to the text and to show them what is relevant and important. Thus, it is, in essence, text control of the learning process. The generative approach, on the other hand, is held to emphasise not only learner involvement but learner control of the processes that produce comprehension. All of the devices referred to above have been considered by Jonassen as constructive mathemagenic strategies which address meaningfulness by attempting to orient learners to the textual content or by affecting the way they process it, whereas constructive generative processes are intended, primarily, to increase the meaningfulness of textual content.

Generative Processing	Mathemagenic Processing
Constructive	Constructive
Notetaking	Instructional objectives
Paraphrasing/summarizing	Branching programmed instruction
Synthesizing	Advance organizers
Generating questions	Inserted questions (pretest)
Imaging/illustrating	Titles/headings/markers
Mapping/networking	Graphic organizers
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Learner control	Text control

This dichotomy is based on the work of Wittrock (1974) with respect to a generative model of learning which suggests that reading comprehension is facilitated when, during encoding, learners use their memories of events and experiences to construct meanings for the text. The actively constructed individualised meanings represent each learner's comprehension of the text, a view which is consistent with the schema-theoretic view of reading comprehension. Later work on generative processes (Doctorow, Wittrock & Marks, 1978) indicates that generative processing involves instructions to the reader to generate associations among words, to generate pictures and to generate meaningful elaborations, activities which go beyond the constructivist schema-theoretic view of reading comprehension. In this case of 'generative' learning, the reader is not only generating meaning, but generating overt performance which can

contribute to learning. Jonassen's constructive mathemagenic and constructive generative terms certainly distinguish between those activities of constructing meaning and the overt articulation of that meaning, but the conclusion that the former is an example of 'text control' while the latter is an example of 'learner control' does not seem to be justified. Both involve cognitive processing in which the learner is in control, but the former could be referred to as 'text-induced' cognitive processing.

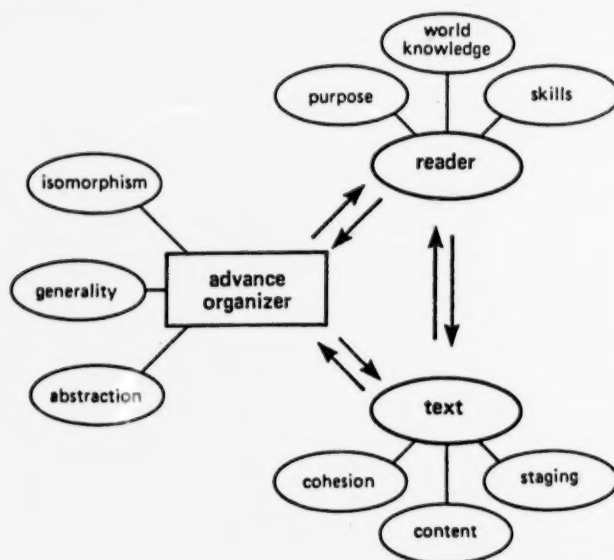
It is in that context that the role of adjunct aids is reconsidered.

(a) *advance organizers*

Anderson (1984) has claimed that schema theory supports the practice of providing advance organizers or structured overviews along the lines proposed by Ausubel whom he regards as one of the pioneer schema theorists, although he has reservations about Ausubel's insistence that organizers must be stated at a high level of generality, abstractness, and inclusiveness.

There seems to be little point in debating the precise nature of an advance organizer. The suggestion that "if it works, it is an advance organizer" is worth considering, whether the degree of abstractness or generalisability necessary for a true organizer has been demonstrated. Perhaps the phenomenon of success is more important. Thus, if verbal material provided prior to the main text is able to activate schema and prior knowledge in the reader, and is able through this and through its own structure to set the framework and organisation of the following text, then it is creating a 'set to learn' context and is, in a real sense, an advance organizer.

Stewart (1986) proposed a diagrammatic representation of the system which could account for the possible functioning or malfunctioning of advance organizers. In the



system, the text is the starting point since it is the first part of the system to be created. From the text, the advance organizer is developed, then the reader interacts, first with the advance organizer and then with the main body of the text.

- The text

The way in which the text is written, ie the way in which the content is treated with respect to top-level structure etc, the way in which main features are highlighted, and the way in which cohesion is achieved, will affect not only the comprehension process as the reader reacts with the text, but will also affect the possibilities for the construction of the advance organizer. The text, therefore, may be well structured or poorly structured with respect to all three variables, or it may be anywhere in between.

- The organizer

Whether it is prepared in accordance with Ausubelian parameters or not, the *de facto* advance organizer may extend from a single word (as in a title) to, perhaps, a 1000 word mini-discourse and, within that continuum, may have a varying degree of isomorphism (ie the extent to which it reflects the structure of the text), and may have varying degrees of generality and abstraction.

- The reader

The advance organizer will probably be the first part of the printed material to be read by the reader, and the parameters affecting his/her ability to interact with and learn from text are really just as important in interacting with and learning from the advance organizer (cf Dinnel & Glover, 1985). The reader may or may not have the pre-requisite world knowledge, the declared purpose for reading, or the developed strategies and metacognitive skills necessary to benefit from the advance organizer and, subsequently, from the text.

The many variables, often internally infinitely variable, make it virtually impossible to be definite about when advance organizers will or will not be effective. Nevertheless, having regard to the research evidence concerning advance organizers in relation to prior knowledge and schema theory, Stewart (1986) proposed the following general principle:

"If the reader is oriented by a brief verbal organizer toward the application of existing knowledge to the assimilation of the main features of new knowledge in text, then comprehension of that new knowledge will be facilitated".

This principle, when put into practice, requires an approach to the design of advance organizers which is significantly different from current practice in that there is an overt emphasis on the activation of existing knowledge which, within a traditional approach, might have occurred only because it happened to be part of the way in which advance

organizers operate. Making explicit a need to activate prior knowledge is really guidance to the reader, as is the linking of this to the main features of new knowledge in the text. The organizer with respect to the new knowledge is, however, more in line with the traditional approach to advance organizers. Conceivably, it would be possible to separate the 'guidance' from the 'organizer', but an integrated approach would probably be better and what is required is really an extension or broadening of the concept of advance organizer to include the element of guidance implicit in the identified principle.

(b) *graphic organizers*

From the published research relating to graphic organizers there are clearly two problems. First what can be classified as a graphic organizer and, second, the issue of pre- or post- application.

The second problem is more easily dealt with. Research which deals with graphic post-organizers also deals with reader-generated as opposed to author-provided organizers and, as has already been noted, this sort of activity involves the reader in a generative activity which could require a different level of cognitive processing since overt performance is required.

The first problem of definition is more difficult, but likely to be more useful if resolved. Based upon a verbal-pictorial continuum as proposed by Wileman (1980), Hawk, McLeod, and Jonassen (1985) have argued that graphic organizers can contain both pictorial (iconic sign) and verbal (digital sign) information and that, in accordance with Paivio's (1971) dual coding hypothesis, graphic organizers in text induce dual coding of information. Jonassen & Hawk (1983) have identified the need to ensure in a graphic organizer that the location of graphic elements depicting the main points and the way they are spatially related on an organizer corresponds to the semantic relationship between the 'main' ideas, and, also, that the graphic relationships are structurally isomorphic to the semantic relationships in the content, a point that has also been made by Schwarz & Kulhavy (1982).

What constitutes a graphic advance organizer is really any appropriate mixture of verbal and graphic material which relates to the structure of the text. At the intuitive level, there is a case for graphic organizers being particularly effective when the intention is to relate to structure because there is the potential not only to activate schema and indicate emphasis but, because of the possibility of dual coding or whatever other explanation there is for imagery, a higher level of cognitive operation, viz. relationship between ideas, can be presented as a starting point. It is doubtful whether there has yet been sufficient research carried out in this area. Nevertheless, from the available evidence relating to advance organizers in general and graphical

organizers in particular, together with his own investigation, Stewart (1986) derived the following principle.

"If a graphic organizer is used to convey isomorphically the structure of ideas in text, then comprehension of the structure will be facilitated".

Application of the principle concerning graphic organizers would require change in present practice for the obvious reason that the use of graphic organizers is a relatively rare occurrence. The development of a graphic organizer is a useful exercise when analysing already written text and can readily show up weaknesses and inconsistencies in the structure of the text but it is much more appropriate to try to develop the organizer based on the ideas and their relationships prior to their being put together in the text. The development of a graphic organizer is also a very useful stage in the development of typographical cueing devices since it can identify levels of headings and sub-headings. It really is surprising that graphic organizers are not more commonly found in instructional text considering that they may well have formed part of the author's working out of the ideas to be included in the text. It is because a graphic organizer can depict the structure of ideas in text, in the way that the author intended them to be related, that the graphic organizer is worthwhile adopting in practice.

(c) *adjunct questions*

Research into the effectiveness of adjunct questions has been concerned mainly with the position (before or after), type (factual or meaningful), and frequency of insertion. It has been observed by Linder & Rickards (1985) that all the investigations of Rothkopf (1965) began under the theoretical banner of neo-behaviourism but that recent subsequent research involving adjunct questions has assumed a cognitive perspective which emphasises the active and constructive role of the learner. Research in relation to adjunct questions appears to leave little doubt as to their effectiveness (Anderson & Biddle, 1975; Duchastel & Whitehead, 1980), but Resnick (1985) has noted that there seems to have been only slight progress in the direction of accounting for questioning effects in terms of cognitive processes.

It has been suggested by Hamilton (1985) that subjects normally process the passage at a very superficial semantic level and that verbatim questions, whether pre- or post- are answered on the basis of this level of processing. However, in the case of semantic questions, the pre-questions would not only focus the subject on the relevant prose material but also induce more than a superficial semantic level of processing of the target material, whereas post-questions would have minimal effects on the processing of the target material because they occur after the target material.

Linder & Rickards (1985) have argued that higher-level questions affect not only the level at which material is processed but the manner in which such material is organised in memory, and that higher-level questions therefore affect the quality as well as the quantity of recall. This is consistent with the 'qualitative outcomes of learning' research to be found among European educational researchers (Marton & Saljo, 1984; Entwistle & Ramsden, 1983; Saljo, 1984). If the reader can be induced through the adjunct questions to adopt a 'deep approach' to learning from that particular reading experience, then not only a deep semantic processing, but a more meaningful processing is likely to occur.

Setting the work on adjunct questions in that context led Stewart (1986) to derive the following principle.

"If higher-level questions are inserted in text they are likely to induce a deeper level of processing on the part of the reader"

The key features of the principle relating to adjunct questions, as they affect educational practice, are the emphasis on questions being 'higher-level' and the outcome of their inclusion being a deeper level of processing. While the practice of including questions within text is not uncommon, such questions are often of a factual recall nature and not of the higher-level implied in the principle. No doubt there are times when factual questions are appropriate but where deeper levels of processing are intended, higher level questions need to be included.

(d) *learning objectives*

Hartley & Davis (1976) have noted that, despite a general lack of agreement as to the level of detail to which behavioural objectives should be written, the majority of studies have indicated that behavioural objectives provide a useful pre-instructional strategy. Hamilton (1985), however, has observed that objectives have consistently produced positive effects only for the retention of verbatim information while producing inconsistent effects for the retention of semantic verbal information. It appears, too, that this effect is in relation only to generally described goals or objectives and that the inclusion of other information consistent with the Magerian definition of objectives may, in fact, hinder the effects of the objectives.

To set the above in context, consideration needs to be given to the nature of the instructional objective or learning goal stated. In much of the research literature, many of the objectives have been low-level recall of information. It remains to be seen what would be the effect of a high-level objective. While an advance organizer may activate a particular schema or set of schemata, it is unlikely that the statement of an objective would have the same effect. What is much more likely is that the statement of a

high-level objective (ie high-level in the Bloom or Gagne sense) would induce a set-to-learn from which deep processing would ensue. On this basis, Stewart (1986) proposed the following principle.

"If a high-level learning outcome is stated as an objective in advance of reading, the learner is likely to adopt a deep approach to reading of the passage".

There does not appear to be any research which examines the effectiveness not only of high-level objectives but of high-level inserted questions which measure achievement of the high-level objectives. There is a strong relationship between the implications in practice of the above principle and those associated with the principle concerning inserted questions. In both cases a deep approach is expected. In practice it would be appropriate to implement both principles together by stating the high-level learning outcome in advance of the passage of text and including within the text high-level questions related to the stated learning outcome. Hopefully, the combined effect of both objective and question would be more certain than either independently and would, in fact, result in deeper processing.

Conclusion

It is unfortunate that the concept of mathemagenic activities has been so widely criticised, particularly when contrasted with so-called 'generative' processes. It was made clear by Rothkopf (1982) that the phrase 'mathemagenic activities' was coined to draw attention to the importance of readers' activities in learning from text because, at the time, practitioners and researchers were preoccupied with structural characteristics of text. It has also been made clear (Rothkopf, 1970) that the study of mathemagenic activities is the study of the students' actions that are relevant to the achievement of specified instructional objectives; that the concept of mathemagenic activity implies that a learner's actions play an important role in determining what is being learned; and that the most important determinant of the capabilities a student acquires from printed material is what the student does with the instructional materials.

This is not inconsistent with a cognitive, constructivist, view of reading comprehension, nor does it imply that control of the comprehension process lies in the text. Reading comprehension is an interactive process between reader and text and it is appropriate that verbal cueing (whether it be considered mathemagenic or not) should be used to facilitate achievement of the desired learning outcome. For the instructional designer, the reconsideration of adjunct aids as verbal cueing devices within a cognitive perspective of the reading process provides a defensible framework and challenges the designer to implement on a basis of principle rather than practice.

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